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Appendix I

Communication Systems Interference Analysis

LRTP 22 - Big Stone South 765 kV Project

Northern States Power Company

South Dakota

Communication Systems (AM/FM Radio, TV, LMR, and Communications Towers) Interference Analysis

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Introduction

Capitol Airspace conducted a communication systems interference analysis for the LRTP 22 - Big Stone South 765 kV project in South Dakota. At the time of this analysis, a 130 kilometer (80.7 mile) transmission line (***Figure 1***) was identified for analysis. A 3000 foot buffer area (dark gray dotted line, ***Figure 1***) was placed around the transmission line as the area to be studied. The purpose of this analysis was to identify Amplitude Modulation (AM) and Frequency Modulation (FM) Radio, Television (TV), Land Mobile Radio (LMR) systems, and communications towers potentially carrying E911 service which may be impacted by this project.

AM and FM radio, along with TV stations, are a critical component of the national communications infrastructure. These stations broadcast emergency, news, music, entertainment, and educational content. LMR systems play a critical role in enabling seamless communication among public safety agencies, emergency responders, and transportation services, ensuring swift and coordinated responses to urgent situations and enhancing overall public safety nationwide. Proposed structures that interfere with these systems can degrade the services that they provide.

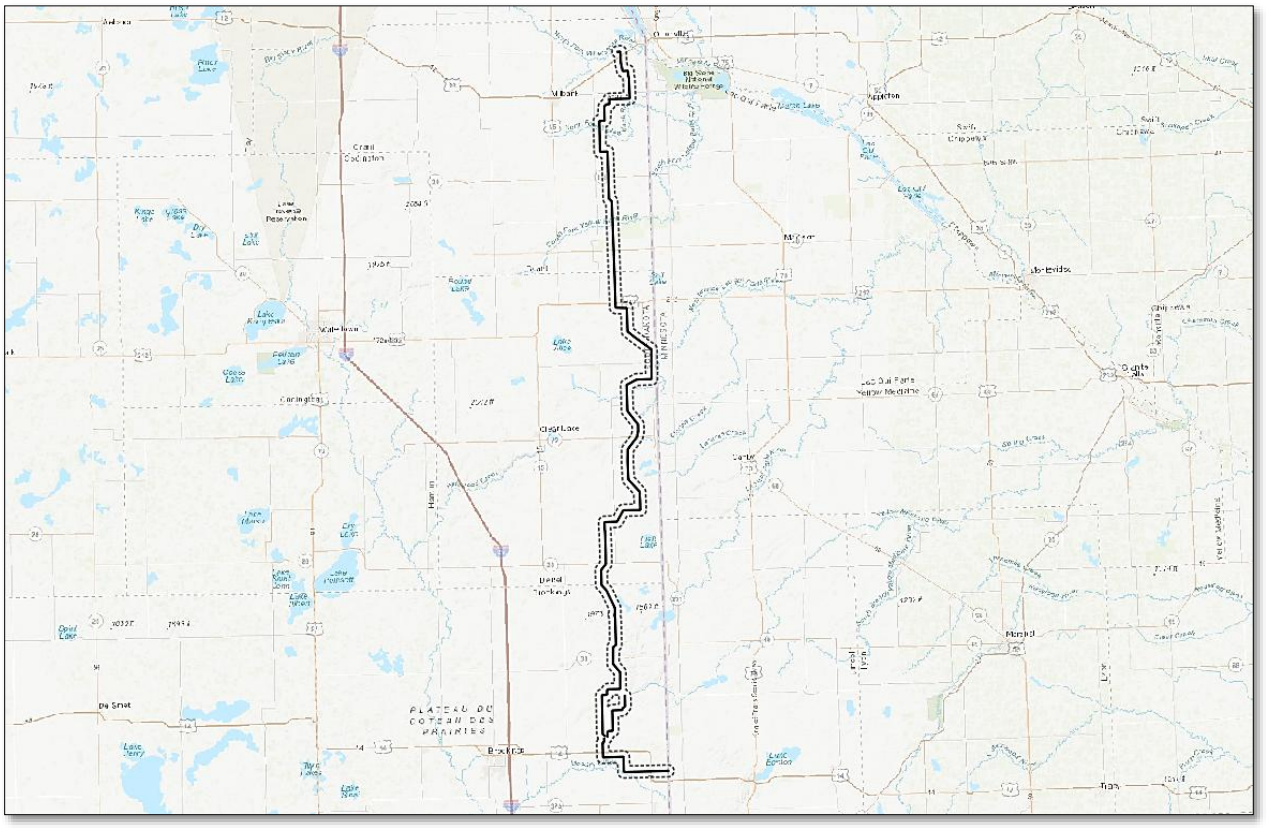

Figure 1: LRTP 22 - Big Stone South 765 kV project boundary

Transmission lines have the potential to disrupt communication systems by physical obstruction of the antenna pattern as well as interference at the receiver. The likelihood of disruption depends on the characteristics of the radio frequency (RF) signal and the proximity of transmission lines to communication system components. Therefore, the proximity of a transmission line to a communication facility plays a crucial role in predicting potential interference. This analysis focuses on understanding how the placement of transmission lines relates to the probability of interference.

Methodology

Capitol Airspace studied the proposed project based upon location information provided by Northern States Power Company. Using this information, Capitol Airspace used a Geographic Information System (GIS) to determine proximity to communication facilities contained in the Federal Communication Commission (FCC) Universal Licensing System (ULS), Licensing and Management System (LMS), and Antenna Structure Registration (ASR) databases. Additional non-FCC tower databases were also used to determine locations of un-registered towers.

This analysis considers the potential impact of the proposed transmission line project on communication system transmission facilities based on RF signal propagation characteristics, and on RF reception based on Electromagnetic Interference (EMI, or "RF Noise") from the transmission line segments.

AM Radio

Proposed structures located within 6 kilometers (km) of an AM radio station's transmitter site can have an impact on the station's licensed coverage pattern. The triggering distance for consideration, notification, and possible remedial actions is based on guidance provided by the FCC via 47 CFR §1.30002. If transmission lines are placed within that distance, Northern States Power Company should notify the radio station and may have to remediate any issues that arise by that placement. Remediation is relatively simple when done by qualified RF consultants. Properly installed and maintained 765 kV transmission lines of this height should not cause electrical noise to AM reception outside a distance of 100 meters (328 feet).

FM Radio and TV

The location of a proposed structure within an RF signal's propagation regions can determine the potential for impact (***Figure 2***). Within the near field, RF signals behave unpredictably and are more susceptible to distortion from obstacles. In the far field, radio waves are more parallel and uniform and have spread over a larger area. Obstacles in the far field are less likely to have an impact on RF signals. The distance to the end of the near field is called the "Fraunhofer distance". [1]

[1] The Fraunhofer Distance (d_f) is calculated as follows: $d_f = 2D^2/\lambda$, where D is the dimension of the antenna aperture and λ is the wavelength of the signal.

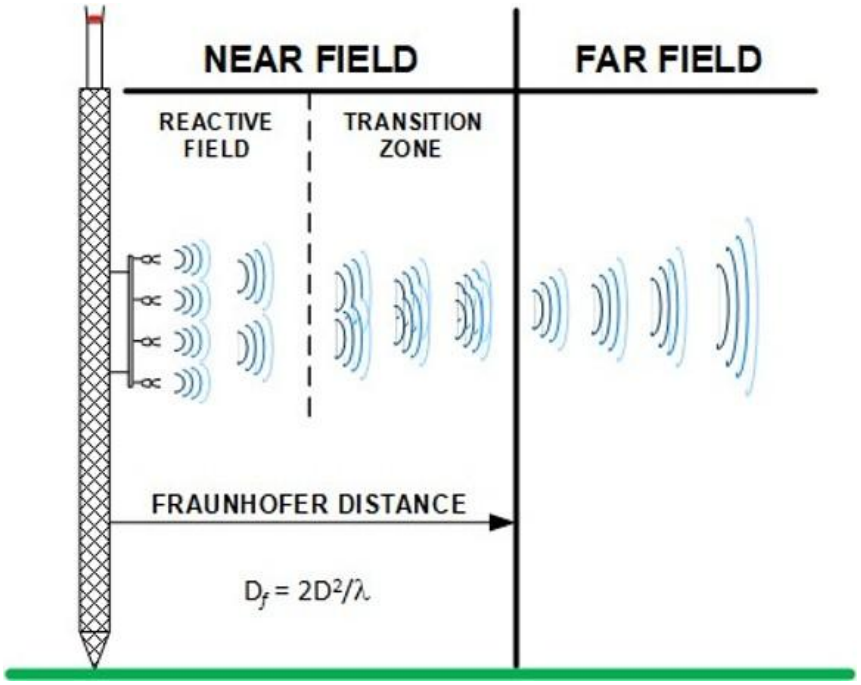

Figure 2: RF signal transition from the near-field to the far-field of a transmitter

LMR and Cellular

Proposed structures like transmission lines also affect LMR and cellular transmission and reception in the same way that they affect FM and TV stations, as the frequencies are similar. The LMR and cellular antennas are evaluated for a worst-case distance from the transmission line so that they are not affected by any physical obstruction of the proposed transmission line.

In many cases, ULS and LMS antenna locations as well as antenna structure registration (ASR) tower locations are inaccurate. When a communication system transmitter's location was critical, available satellite and aerial imagery were used to improve its coordinates. Available imagery was also used to identify potential receivers in proximity to the project boundary.

Findings

AM Radio

AM Radio Transmission

Large metal structures located within ten wavelengths of an AM radio station transmitter site have the potential to adversely affect AM transmission. FCC Rule Section 1.30002 details the notification process that should be undertaken when transmission lines are built near an AM station. This FCC Rule addresses the addition of large structures which can cause the AM station facility to be out of compliance with their FCC license depending on their height and proximity to the AM station. There are no AM stations within 3000 feet of the proposed transmission line. KMSD(AM) is the closest AM station to the project. It is a non-directional AM station at 1510 kHz, 7.3 km west of the proposed transmission line (***Table 1*** and ***Figure 3***). To satisfy FCC Rule Section 1.30002(a), transmission lines should be sited at least one wavelength from a non-directional AM station. In the case of KMSD(AM), the one-wavelength distance is 200 meters. Since this 200-meter notification distance does not intersect the project buffer, there should be no impact to this or any other AM station, and the station does not have to be notified of construction.

AM Radio Reception

Even a properly installed and maintained transmission line[2] has the ability to cause noise through electrical field and magnetic field "coupling" which affects AM receivers. The setback distance from the transmission line to a potential AM receiver is based on the transmission line support structure height which is twice the height of the tallest transmission line tower. The tallest support structure in the project is assumed to be no taller than 200 feet, so the setback distance to avoid AM receiver interference in houses and buildings would be 400 feet, or roughly 122 meters. When examining aerial imagery, there appears to be no place where any of the transmission line segments are closer than 122 meters to any habitable buildings where AM receivers might exist. Vehicles traveling on roadways past or under the transmission lines may experience temporary AM reception "buzz", which will dissipate quickly.

Table 1: AM radio transmitters in proximity to the LRTP 22 - Big Stone South 765 kV project

Licensee	Call Sign	Frequency (kHz)	Antenna	Notification Distance (m/ft)	Distance to Nearest T-Line (km)	Coordinates
Prairie Winds Broadcasting, Inc.	KMSD(AM)	1510	Non-Directional	200/656	7.3	45 11 39.90 N, 96 38 22.20 W

[2] Proper installation includes grounding and bonding, and corona suppression mechanisms. Proper maintenance includes checking, repairing and replacing such items periodically.

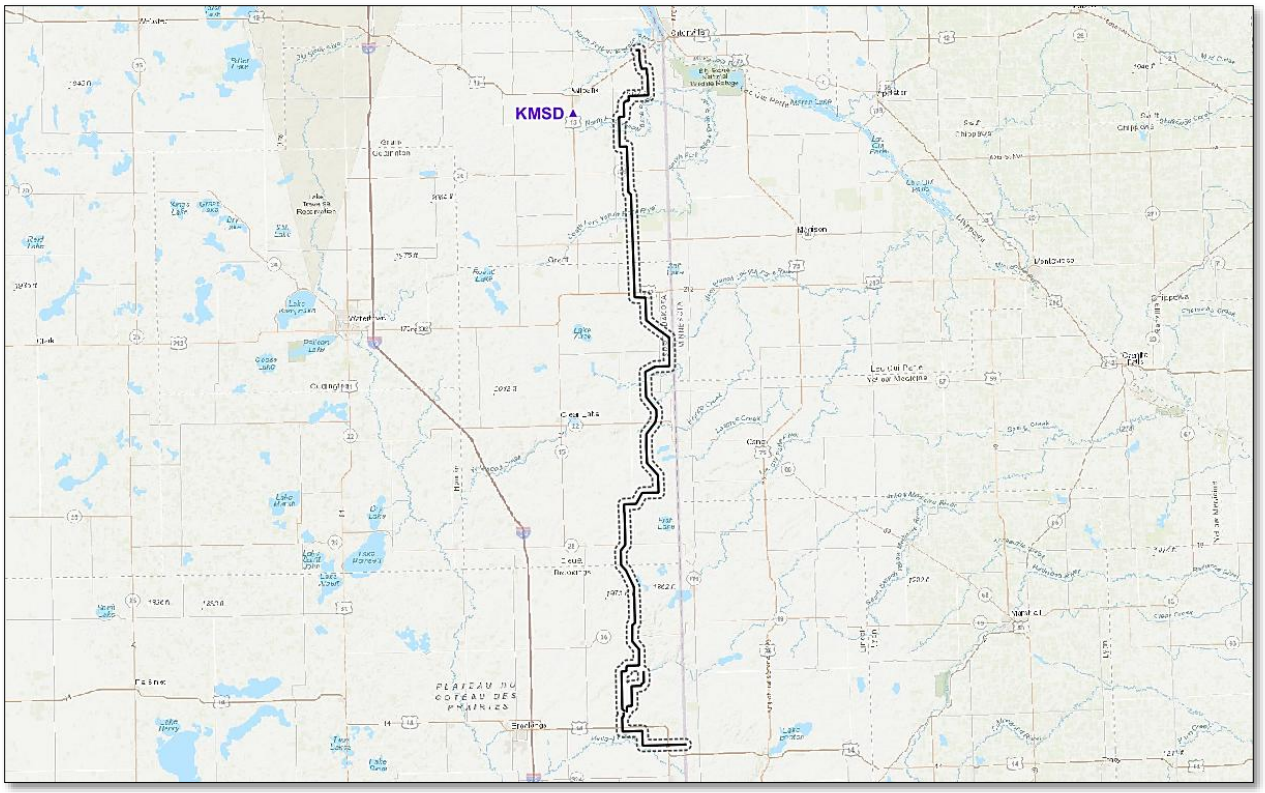

Figure 3: AM radio transmitter (purple triangle) in proximity to the LRTP 22 - Big Stone South 765 kV project

FM Radio

FM Radio Transmission

The effects of the proposed project on FM radio transmission are predominantly physical in nature. The concern is that tall structures built within an FM transmitting antenna's near field (see ***Figure 2***) will distort the transmitted signal. There are no FM transmitter facilities located within 3000 feet of the transmission line (***Table 2*** and ***Figure 4***). FM translator K236CU is 7.3 km west of the transmission line. From the near field distance discussion in ***Figure 2***, the far-field distance of the K236CU antenna is less than 20 meters. Since the antenna far field distance is far less than the distance to the proposed transmission line, there should be no adverse effect on this, or any other nearby FM radio station transmissions.

FM Radio Reception

Unless the transmission lines are sited within 50 meters (165 feet) of a potential receiver (houses, businesses and roads), it is unlikely that the transmission lines will have a perceivable EMI impact on FM radio reception. Study of aerial imagery indicates that there are no potential houses or buildings within this distance of any of the transmission line segments. Vehicles traveling on roads in proximity to the transmission line project should experience only fleeting interruption in signal, if at all.

Table 2: FM radio transmitters in proximity to the LRTP 22 - Big Stone South 765 kV project

Licensee	Call Sign	Status	Frequency (MHz)	Distance to T-Line (km)	Near Field Radius (m)	Coordinates
Prairie Winds Broadcasting, Inc.	K236CU	License	95.1	7.3	<20	45 11 39.90 N, 96 38 22.20 W

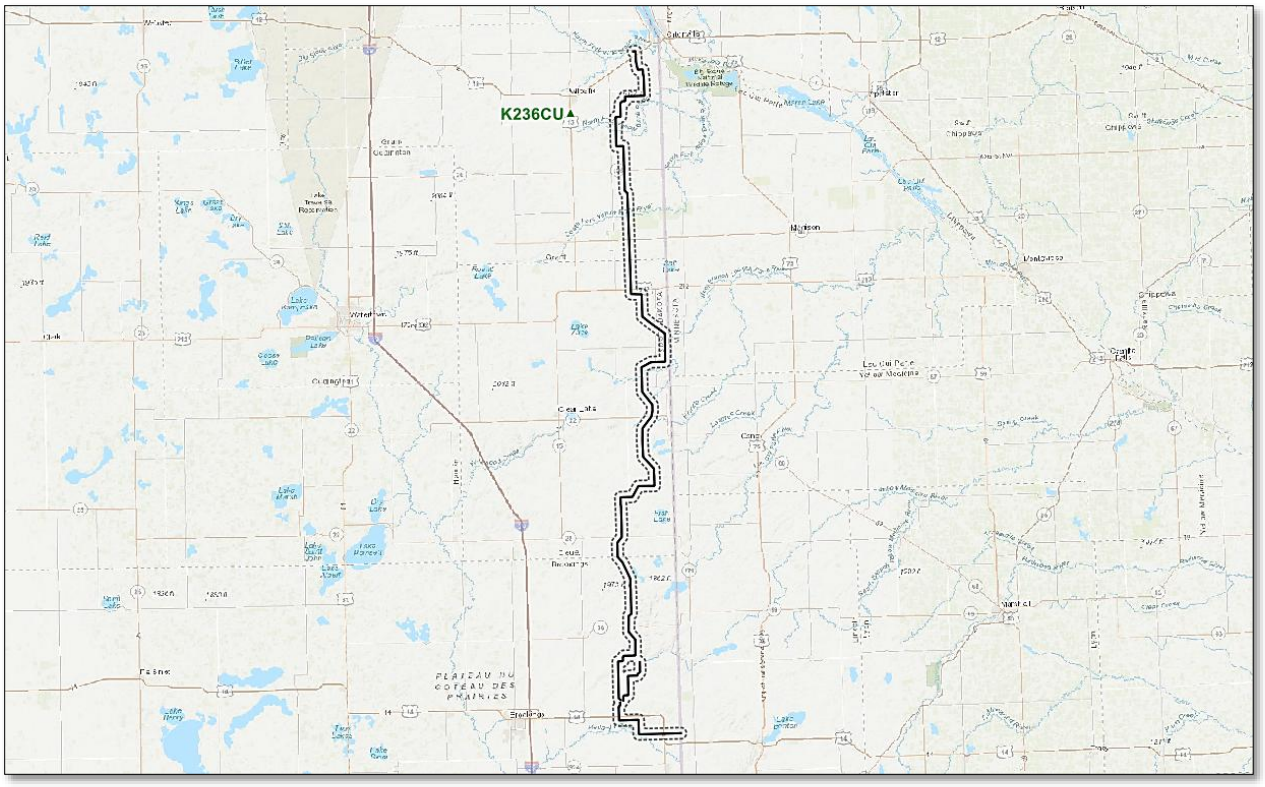

Figure 4: FM radio transmitter (green triangle) in proximity to the LRTP 22 - Big Stone South 765 kV project

Television (TV)

TV Transmission

Similar to FM radio, which is also a "line of sight" service, the effects of the proposed project on TV transmission are predominantly physical in nature. The concern is that tall structures built within the TV transmitting antenna's near field (see ***Figure 2***) will distort the transmitted signal. There are no TV transmitter facilities located within 3000 feet of the proposed transmission line (***Table 3*** and ***Figure 5***). Low power TV station K25OU-D is 15.1 km west of the project. From the near field distance discussion in ***Figure 2***, the far-field distance of the K25OU-D antenna is 163 meters. Since the antenna far field distance is far less than the distance to the transmission line segment, there should be no adverse effect on this, or any other nearby TV station transmissions.

TV Reception

Unless the transmission lines are installed within 50 meters (165 feet) of a potential TV receiver (houses or businesses), it is unlikely that the transmission lines will have a perceivable EMI impact on television reception. Study of aerial imagery indicates that there are no potential houses or buildings within this distance of any of the transmission line segments.

Table 3: TV transmitters in proximity to the LRTP 22 - Big Stone South 765 kV project

Licensee	Call Sign	Status	Coordinates	Near Field Radius (m)	Distance to T-Line (km)
Gray Television Licensee, LLC	K25OU-D	License	44 18 03.00 N, 96 46 00.00 W	163	15.1

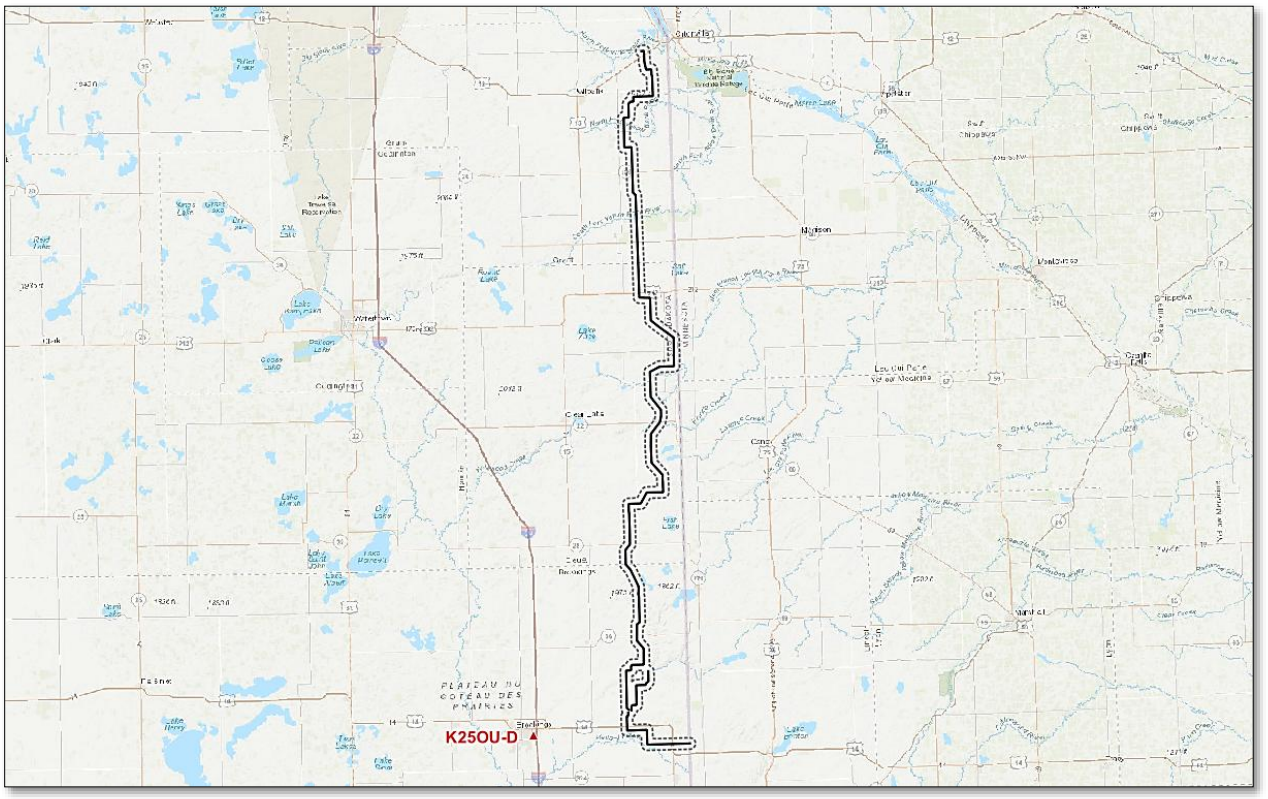

Figure 5: TV transmitter (red triangle) in proximity to the LRTP 22 - Big Stone South 765 kV project

Land Mobile Radio (LMR)

LMR Base Station (Fixed Site) Transmission and Reception

Land mobile radio systems operate at both VHF and UHF, and LMR radios are typically both transmitters and receivers. Unless the transmission lines are sited within 50 meters (165 feet) of a VHF LMR base station radio (houses or businesses), or within 30 meters of a UHF LMR base station, it is unlikely that the transmission lines will have a perceivable EMI impact on transmission or reception. Study of aerial imagery indicates that there are no houses or buildings within this distance of any of the transmission line segments. There are four licensed LMR base stations within the 3000 foot buffer around the transmission line project (***Table 4*** and ***Figure 6***). However, none of them is within 50 meters of the transmission line, so there should be no impact to LMR base station transmission.

Table 4: LMR base stations within 3000 feet of the LRTP 22 - Big Stone South 765 kV project

Licensee	Call Sign	Location	Status	Frequency (MHz)	Distance to T-Line Segment (m/ ft)	Corrected Coordinates
Wollschlager, Chuck	KNIZ313	2	License	151.5350	321/1,053	45 06 25.00 N, 96 32 14.55 W
Granite View Farms	WQPP608	1	License	461.1000	464/1,522	45 12 48.20 N, 96 32 00.90 W
Frogner, Tom	WQNX822	2	License	160.0875	476/1,562	45 08 53.15 N, 96 32 15.50 W
Dakota Granite Co., Inc.	WRWK203	1	License	452.1000	573/1,880	45 12 32.00 N, 96 31 10.20 W

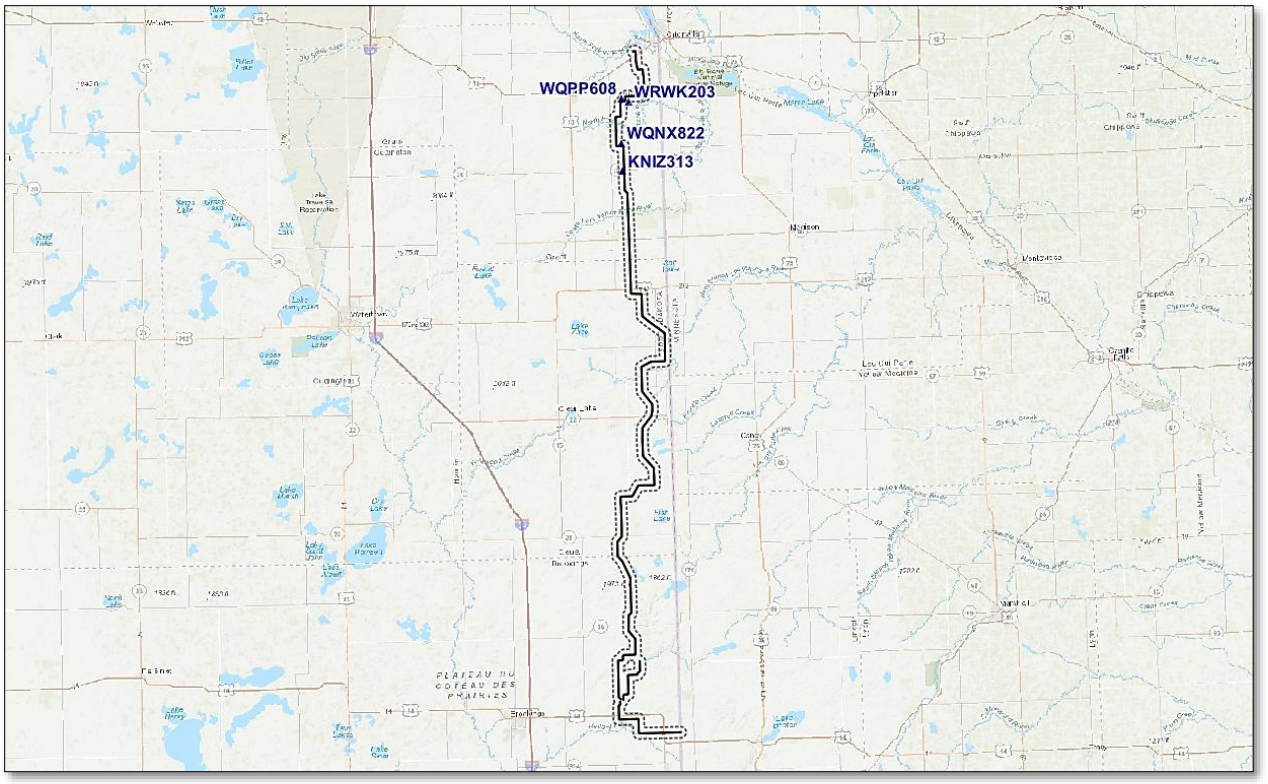

Figure 6: LMR Licenses (dark blue triangles) within 3000 feet of the LRTP 22 – Big Stone South 765 kV project

LMR Mobile Transmission and Reception

The signal from a mobile LMR radio is generally broad and can scatter around intervening physical objects like transmission lines, and typical LMR systems employ redundant systems such as multiple transceivers in their design as a means of ensuring service in a region, so there should be little impact to LMR mobile reception. Since mobile radios are frequently in motion, users of handheld radios often adjust their positions to address any interference. There should be no impact from the transmission line project to land mobile radio licenses.

Other Communications Towers – Cellular Service and E911 Signaling

The primary concern with antenna towers not identified in the sections above is the potential for interference to cellular service. Similar to LMR radios, cellular radio systems on towers both transmit and receive. Unless the transmission lines are sited within 30 meters (98 feet) of a tower with a cellular radio, there should be no impact from the transmission line to either cellular transmission or reception. In fact, there are many cases in the U.S. where there is cellular service mounted on towers either directly next to or on high-power transmission line towers; Further, there are no known communications towers or cellular licenses within 3000 feet of the proposed transmission line (***Table 5*** and ***Figure 7***). There should be no impact to any cellular service or E911 signaling from the transmission line project.

Table 5: Communications towers in proximity to the LRTP 22 - Big Stone South 765 kV project

Cellular Callsign	FCC ASRN	Tower Owner	Height Above Ground (m)	Distance to Nearest T-Line (m/ft)	Corrected Coordinates
N/A	1040232	East River Electric Power	93.8	1,273/4,176	44 50 58.10 N, 96 28 34.85 W
N/A	1042274	Otter Tail Power Company	91.4	1,339/4,393	44 50 58.15 N, 96 28 37.90 W

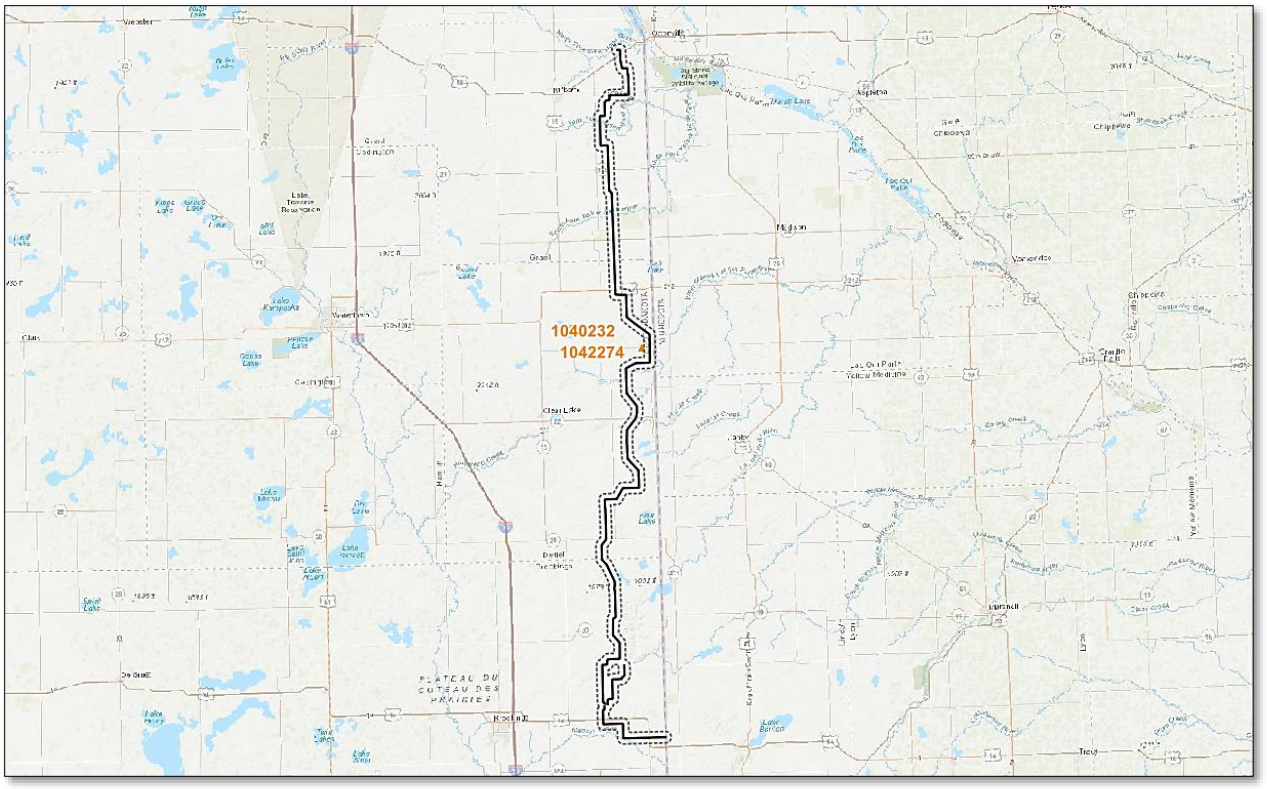

Figure 7: Towers (orange triangles) in proximity to the LRTP 22 - Big Stone South 765 kV project

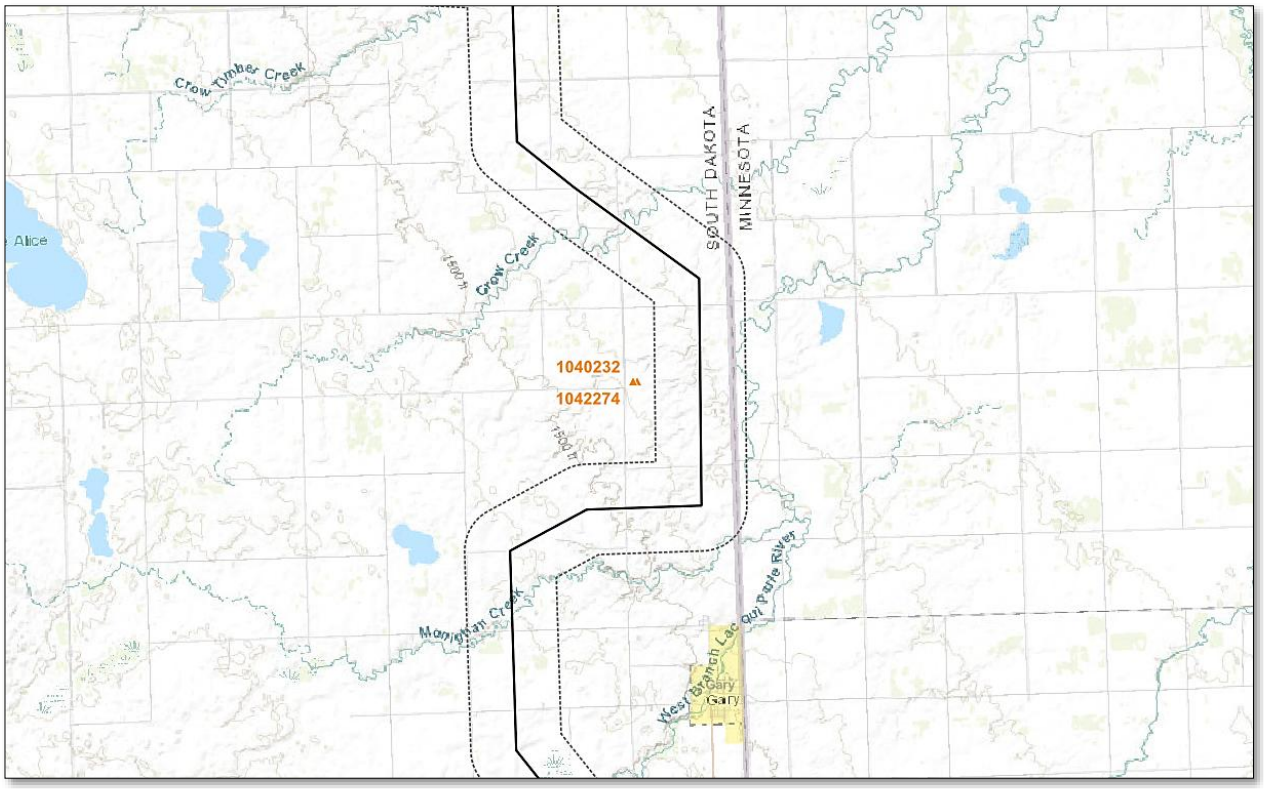

Figure 8: Towers (orange triangles) in proximity to the LRTP 22 – Big Stone South 765 kV project (map expanded for detail)

Conclusion

Capitol Airspace conducted a communication systems interference analysis for the LRTP 22 - Big Stone South 765 kV project. This analysis assessed the potential for impact on various systems

In summary, as long as Northern States Power Company employs proper installation such as grounding and bonding, and corona suppression mechanisms, and proper maintenance such as checking, repairing and replacing such items periodically, and abiding by all the setback recommendations in this report, the analysis indicates that the proposed transmission line project is not expected to cause significant interference to nearby communication systems. Comprehensive evaluations of AM and FM radio, TV, and Land Mobile Radio services, as well as consideration of nearby communication towers, suggest that any potential impacts can be managed through prudent transmission system installation, management, and maintenance.

If you have any questions regarding the findings of this study, please contact ***David Beranek*** or ***Cindy Cavell*** at (703) 256-2485.